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(54) MULTIPLE DISC BRAKE

(71) We, THE BENDIX CORPORATION, a corporation organised and existing under the laws of the State of Delaware, United States of America, of Bendix Center, Southfield, Michigan 48075, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a multiple disc brake having a flexible force transmitting key apparatus.

Conventional multiple disc brakes of the high capacity type such as aircraft brakes include rotor and stator discs having a plurality of circumferentially spaced-apart key slots adapted to engage associated keys secured to a wheel in the case of the rotor disc and to a fixed torque tube in the case of the stator disc. Due to manufacturing tolerance variations in the circumferential spacing and width of the keys as well as the key slots, the rigid keys may not be engaged simultaneously by the rotor or stator disc resulting in the entire torque load being imposed on the keys that are engaged by the rotor or stator disc and thus creating undesirable high stress in the rotor or stator particularly in the region of the associated slots. Such high stress may be very critical particularly in the case of rotors and/or stators formed of brittle material such as carbon, beryllium, ceramics and the like of high heat capacity and resistance to deterioration from high temperature which are being proposed for use as a substitute for conventional metal such as steel, etc., rotor and/or stator discs.

Various other disadvantages of conventional rigid key constructions particularly in aircraft brakes include the weight penalty attributed to solid key members and manufacturing costs caused by accurate machining requirements to adapt the wheel for such solid key members and undesirable high heat transfer characteristics of solid key members which tend to promote undesired heat transfer from the relatively hot brake section (rotors, stators, etc.) to the wheel including tire mounted thereon.

According to the invention there is provided a multiple disc brake comprising at least one annular member rotatably driven by a wheel member and frictionally engageable with at least another annular member rotatably fixed to a fixed support member, wherein at least one resilient key apparatus defines a plurality of resilient key members which are interposed between at least one of said wheel and fixed support members and its associated annular member for resisting relative rotational motion therebetween, first means operatively connecting said resilient key members to said one of said wheel and fixed support members, second means operatively connecting said resilient key members to said associated annular member, each of said key members being independently engageable with said one of said wheel and fixed support members and said associated annular member, and adapted to deform circumferentially with respect to said annular members under the force load generated by the frictional engagement between said annular members, to an extent permitting engagement of all of said resilient key members with both of said one of said wheel and fixed support members and said associated annular member.

The invention will be now described by way of example with reference to the accompanying drawings in which:—

Figure 1 represents a sectional view of a aircraft multiple disc brake embodying the present invention;

Figure 2 represents a section view taken along line 2—2 of Figure 1;

Figure 3 represents a section view taken on line 3—3 of Figure 2;

Figure 4 represents a section view taken on line 4—4 of Figure 2;

Figure 5 represents another embodiment of the present invention;

Figure 6 represents another embodiment of the present invention; and

axially extending circumferentially spaced-apart grooves or recesses 88 in rim portion 22 and wherein the radially inwardly extending curved or key portions 90 thereof engage mating circumferentially spaced-apart grooves or recesses 92 in rotor members 44. It will be understood that the serpentine shape of band 84 may take various forms other than sinusoidal as, for example, by flattening alternate curved portions to reduce the number of curved key portions 86 or 90 engageable with rim portion 22 or rotor members 44. A significant advantage of the annular band 84 is that it may serve as a heat shield in addition to key means thereby eliminating the necessity of providing a separate heat shield as in the case of shield 74 in Figure 1.

Referring to Figure 6, the embodiment shown therein includes a plurality of axially extending circumferentially spaced-apart sheet metal key members 94 only one of which is shown. Each key member 94 is defined by spaced-apart sheet metal tubular sections 96 and 98 joined by integral flat wall portions 100 and 102 which, in cross section, may be termed "dumbell shaped". The wall portions 100 and 102 are suitably apertured to provide a plurality of axially spaced-apart openings through which fastening means such as screws 104 extend into threaded engagement with a rib or chine 106 formed on rim portion 22 to thereby secure key member 94 in position therein. A backing strip 108 having suitable openings to receive screws 104 may be provided to securely clamp wall portions 100 and 102 against rib or chine 106. As shown in Figure 6, the width of rib or chine 106 is somewhat greater than the width of flat wall portions 100 and 102 and the edges thereof curved to mate with the adjacent curved walls of tubular sections 96 and 98 thereby providing a seat for a portion of tubular sections 96 and 98. The lower portions, i.e., the curved portions depending from wall portion 102, of tubular sections 96 and 98 extend into an axially extending groove or recess 110 in the radially outermost portion of rotor member 44 to thereby rotatably couple rim portion 22 and rotor member 44.

Referring to Figure 7, the embodiment shown therein includes a plurality of circumferentially spaced-apart generally U-shaped axially extending sheet metal key members 112 only one of which is shown. The side portions of each key member 112 are held in spaced-apart relationship by an axially extending rib or chine 114. Each rib or chine 114 is provided with a plurality of axially spaced-apart openings 116 which are aligned with corresponding openings in the side walls of key member 112 to receive fastening means such as rivets 118 which fixedly secure key member 112 in position on rib or chine 114. The base portion of key member 112 extends into mating grooves or recesses 120 formed in the radially outermost portion of rotor members 44 to thereby rotatably couple rim portion 22 and rotor members 44.

Referring to Figure 1, pressurized fluid is applied to pistons 36 to effect frictional engagement of the rotors 44 and stators 46 between pressure plate 48 and backing plate 40. The resulting force tending to retard rotation of rim portion 22 is transmitted through the rotor key members 60 as well as stator key members 78.

Assuming that a rotor member or members 44 engages one or possibly two or three of the key members 60, it will be recognized that the retarding force or torque applied to rim portion 22 will be borne solely by the engaged keys thereby tending to create undesirable high localized force loading on rotor member 44 as well as the rim portion 22 both of which bear against the keys. Since rotor members 44 are preferably formed of carbon or similar relatively weak material, the ability of the same to withstand high stress particularly in the tension or shear modes is limited accordingly thereby making the rotor members 44 vulnerable to structural failure should the force load be unequally divided to a significant extent as would occur in the case of prior art unyielding key members. However, in the case of flexible key members 60, the above-mentioned relatively few key members subjected to the entire force load will tend to deform depending upon the spring rate thereof in the direction of the force applied thereagainst by rotor member 44. The deformation of the key members 60 allows the rotor member 44 to rotate relative to rim portion 22 to the extent that one or more of the remaining key members 60 are engaged by rotor member 44 which, in turn, reduces the portion of the total force load imposed on any given previously engaged key member 60. It will be noted that a progressive increase in force load tending to retard rotation of rim portion 22 ultimately results in progressive engagement of any given rotor member 44 with all of the key members 60 engageable therewithin as a result of the above-mentioned flexible characteristic of key members 60.

The stator members 46 are preferably formed of carbon or the like material and, like rotor members 44, are vulnerable to structural failure in the event of localized high stress particularly in the region of the grooves or recesses 82. The key members 78 engaged by stator members 46 function in the same manner as key members 60 heretofore described with the exception that

cluding a recess formed in said associated annular member and adapted to receive said spaced apart tubular metal portions.

7. A multiple disc brake as claimed in Claim 1, wherein said resilient key apparatus is an arcuate sheet of flexible metal having a first series of radially extending circumferentially spaced-apart loop portions and a second series of oppositely extending spaced-apart loop portions interconnecting said first series of loop portions, said first means including a plurality of radially extending circumferentially spaced-apart recesses formed in said one of said wheel and fixed support members and adapted to receive said first series of loop portions, and said second means including a plurality of radially extending circumferentially spaced-apart recesses formed in said associated annular member and adapted to receive said second series of loop portions.

8. A multiple disc brake as claimed in claim 7, wherein said frictionally engageable annular members are a plurality of axially aligned stator members and a plurality of axially aligned rotor members interposed therebetween, said arcuate sheet of flexible metal defining a cylinder having said first and second series of loop portions extending axially therein, said cylinder being interposed between said wheel member and said plurality of stator and rotor members to provide a heat barrier or shield to minimize heat transfer therebetween.

9. A multiple disc brake as claimed in claim 8, wherein said cylinder having said first and second series of loop portions slidably engages said plurality of stator and rotor members for axial movement thereof.

10. A multiple disc brake substantially as hereinabove described and as illustrated in the accompanying drawings.

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1350350 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

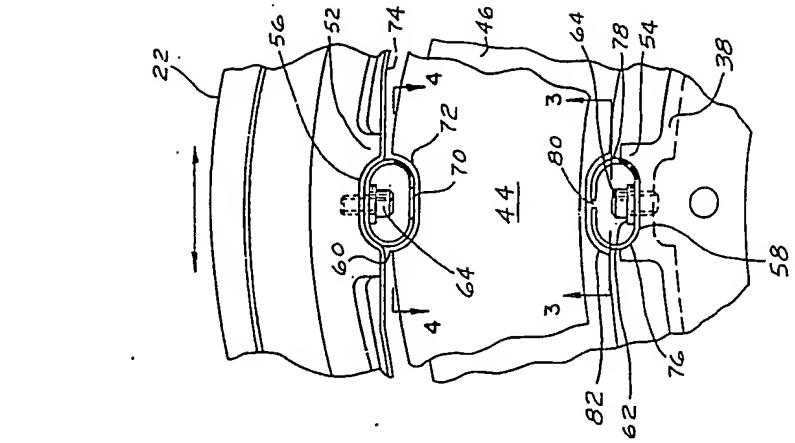

FIG. 2

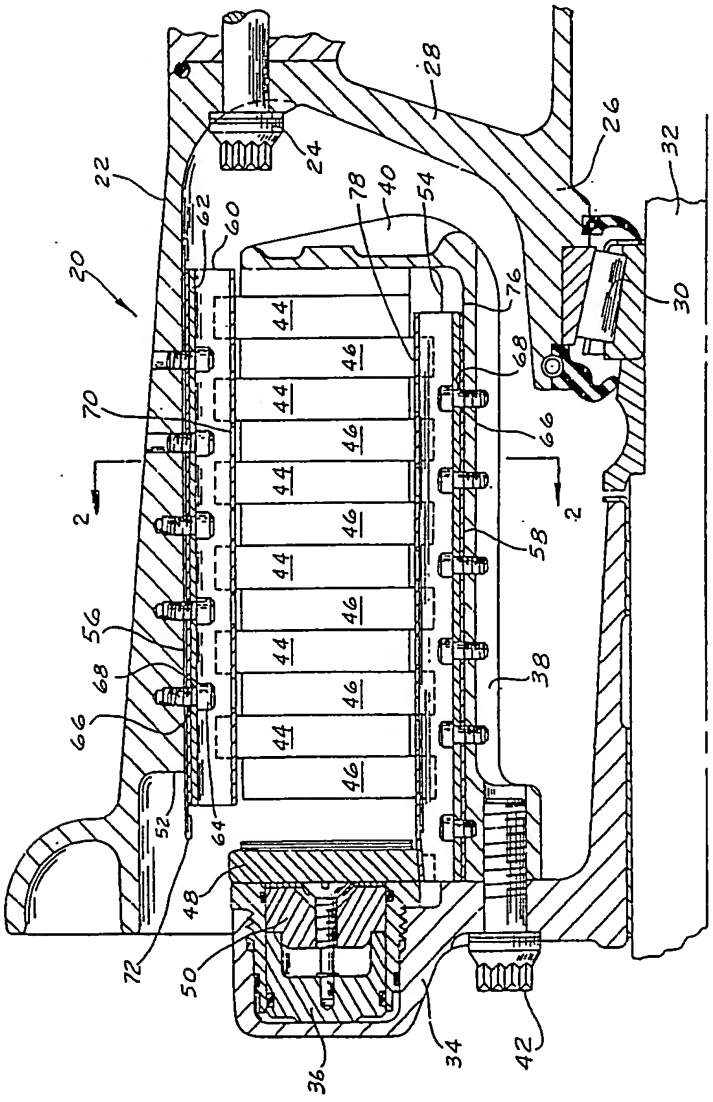

FIG. 1

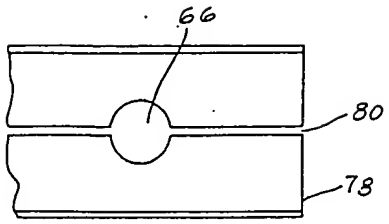

FIG. 3

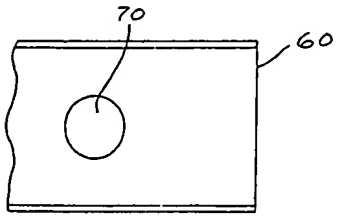

FIG. 4

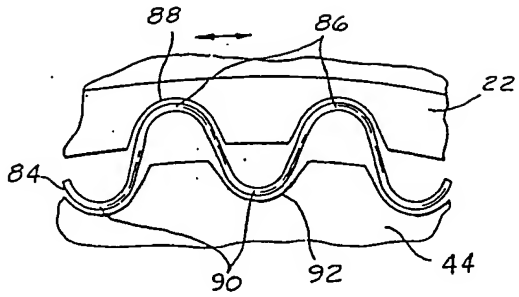

FIG. 5

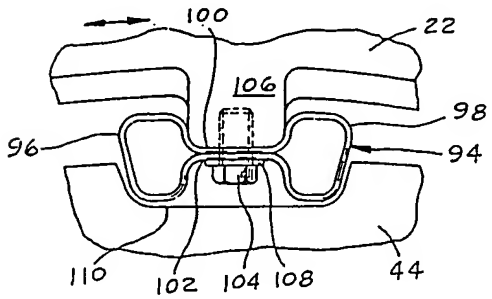

FIG. 6

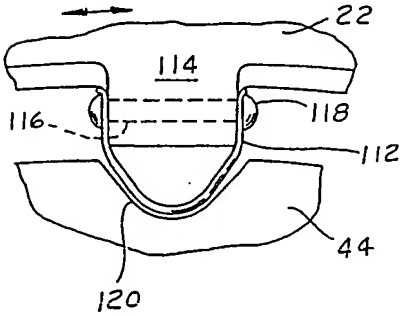

FIG. 7